CLAIMS

WHAT IS CLAIMED IS:

1. In a video signal processing system, a method of computing a motion decision value, which comprises the following steps:

inputting a video signal with an interlaced video sequence of fields;

computing a frame difference signal from a difference between a previous field and a next field in the video sequence;

forming a point-wise motion detection signal from the frame difference signal;

computing a region-wise motion detection signal from the point-wise motion detection signal and an adjacent point-wise motion detection signal delayed by one field; and

forming from the region-wise motion detection signal a motion decision value and outputting the motion decision value for further processing in the video signal processing system.

2. The method according to claim 1, which further comprises low-pass filtering the difference signal prior to the step of forming the point-wise motion detection signal.

3. The method according to claim 2, wherein the step of low-pass filtering is defined by a low pass filter matrix

$$W_{MxN} = \begin{bmatrix} w_{11} & w_{12} & \cdots & w_{1N} \\ w_{21} & w_{22} & \cdots & w_{2N} \\ \vdots & \vdots & \ddots & \vdots \\ w_{M1} & w_{M2} & \cdots & w_{MN} \end{bmatrix}$$

where $w_{11}, \ldots w_{MN}$ represent a set of predetermined coefficients.

4. The method according to claim 1, wherein the step of forming the point-wise motion detection signal comprises computing

$$f_n(i,h) = l_K(d_n(i,h))$$

where f_n is the point-wise motion detection signal, i and h define a spatial location of the respective video signal value in a cartesian matrix, $l_K(\cdot)$ denotes a linearly scaling function represented as

$$l_K(y) = \begin{Bmatrix} 1, & if & y \geq K \\ y/K, & & otherwise \end{Bmatrix}$$

in which K is a positive constant value.

5. The method according to claim 1, wherein the step of forming the point-wise motion detection signal comprises computing

$$f_n(i,h) = l_K(d_n(i,h))$$

where f_n is the point-wise motion detection signal, i and h define a spatial location of the respective video signal value in a cartesian matrix, $l_K(\cdot)$ denotes a linearly scaling function represented as

$$l_K(y) = \begin{Bmatrix} 1, & if & y \geq K \\ (y/K)^a & & otherwise \end{Bmatrix}$$

where K is a positive constant value and a is a real number.

6. The method according to claim 1, wherein the region-wise motion detection signal is computed from the point-wise motion detection signal by an equation selected from the group consisting of

$$\phi_n(i,h) = f_n(i,h) + \min(f_{n-1}(i-1,h), f_{n-1}(i+1,h))$$
$$\phi_n(i,h) = med(f_n(i,h), f_{n-1}(i-1,h), f_{n-1}(i+1,h))$$
$$\phi_n(i,h) = \max(f_n(i,h), f_{n-1}(i-1,h), f_{n-1}(i+1,h))$$

where $f_{n-1}(\cdot)$ denotes a motion detection signal delayed by one field, $med(\cdot)$ denotes a median operation, $max(\cdot)$ denotes an operation to minimize an error from a false motion detection, and the indices i and h define a spatial location of the respective video signal value in a cartesian matrix.

7. The method according to claim 1, which further comprises low-pass filtering the region-wise motion detection signal prior to the outputting step.

8. The method according to claim 7, wherein the region-wise motion detection signal is low-pass filtered to form the motion decision value $m_n(i,h)$ by:

$$m_n(i,h) = \sum_{p=-a}^{b} \sum_{q=-c}^{d} \phi_n(i + 2 \times p, h + 2 \times q) \cdot \alpha_{p,q}$$

where a,b,c,d $\geq$ 0, and $\alpha_{p,q}$ represents a set of normalized predetermined coefficients of a low pass filter.

9. The method according to claim 7, which comprises defining a kernel of the low pass filter as

$$[\alpha_{p,q}'s] = \begin{bmatrix} 0 & 1/8 & 0 \\ 1/8 & 4/8 & 1/8 \\ 0 & 1/8 & 0 \end{bmatrix}.$$

10. In a method of processing interlaced video signals, which comprises:

spatially interpolating a value of the video signal at a given location from a video signal of at least one adjacent location in a given video field;

temporally interpolating the value of the video signal at the given location from a video signal at the same location in temporally adjacent video fields; and

forming a motion decision value for the same location in accordance with claim 1; and

mixing an output signal for the video signal at the given location from the spatially interpolated signal and the temporally interpolated signal and weighting the output signal in accordance with the motion decision value.

11. The method according to claim 10, which comprises varying the motion decision value between 0 and 1 as a function of an estimate of the degree of motion at the given location and, upon estimating a high degree of motion, heavily weighting the output signal towards the spatially interpolated signal and, upon estimating a low degree of motion, heavily weighting the output signal towards the temporally interpolated signal.

12. The method according to claim 11, which comprises outputting the spatially interpolated signal as the output signal upon estimating a high degree of motion, and outputting the temporally interpolated signal as the output signal upon estimating a low degree of motion.

13. In a video signal processing system, an apparatus for computing a motion decision value, comprising:

an input for receiving a video signal with an interlaced video sequence;

difference forming means connected to said input for computing a frame difference signal from a difference between a previous field and a next field of a current field to be deinterlaced;

means for forming a point-wise motion detection signal from the frame difference signal, and for computing a region-wise motion detection signal from the point-wise motion

detection signal and an adjacent point-wise motion detection signal delayed by one field; and

means for forming from the region-wise motion detection signal a motion decision value and for outputting the motion decision value for further processing in the video signal processing system.

14. The apparatus according to claim 14, which further comprises a low-pass filter connected to said difference forming means.

15. The apparatus according to claim 15, wherein said low-pass filter is programmed with a low pass filter matrix

$$W_{M \times N} = \begin{bmatrix} w_{11} & w_{12} & \cdots & w_{1N} \\ w_{21} & w_{22} & \cdots & w_{2N} \\ \vdots & \vdots & \ddots & \vdots \\ w_{M1} & w_{M2} & \cdots & w_{MN} \end{bmatrix}$$

where $w_{11}, \ldots w_{MN}$ represent a set of predetermined coefficients.

16. The apparatus according to claim 13, wherein said means for forming the point-wise motion detection signal are programmed to compute

$$f_n(i,h) = l_K(d_n(i,h))$$

where f_n is the point-wise motion detection signal, i and h define a spatial location of the respective video signal value in a cartesian matrix, $l_K(\cdot)$ denotes a linearly scaling function represented as

$$l_K(y) = \begin{cases} 1, & if \quad y \geq K \\ y/K, & otherwise \end{cases}, \text{ and}$$

K is a positive constant value.

17. The apparatus according to claim 13, wherein said means for forming the point-wise motion detection signal are programmed to compute

$$f_n(i,h) = l_K(d_n(i,h))$$

where f_n is the point-wise motion detection signal, i and h define a spatial location of the respective video signal value in a cartesian matrix, $l_K(\cdot)$ denotes a linearly scaling function represented as

$$l_K(y) = \begin{cases} 1, & if \quad y \geq K \\ (y/K)^a & otherwise \end{cases}, \text{ and}$$

wherein K is a positive constant value and a is a real number.

18. The apparatus according to claim 13, wherein the means for computing the region-wise motion detection signal are programmed to compute the region-wise motion detection signal from the point-wise motion detection signal by an equation selected from the group consisting of

$$\phi_n(i,h) = f_n(i,h) + \min(f_{n-1}(i-1,h), f_{n-1}(i+1,h))$$

$$\phi_n(i,h) = med(f_n(i,h), f_{n-1}(i-1,h), f_{n-1}(i+1,h))$$

$$\phi_n(i,h) = \max(f_n(i,h), f_{n-1}(i-1,h), f_{n-1}(i+1,h))$$

where $f_{n-1}(\cdot)$ denotes a motion detection signal delayed by one field, $med(\cdot)$ denotes a median operation, $max(\cdot)$ denotes an operation to minimize an error from a false motion detection, and the indices i and h define a spatial location of the respective video signal value in a cartesian matrix.

19. The apparatus according to claim 13, which further comprises a low-pass filter connected to an output of said outputting means.

20. The apparatus according to claim 19, wherein said low-pass filter is programmed to filter the region-wise motion detection signal to form the motion decision value $m_n(i,h)$ by:

$$m_n(i,h) = \sum_{p=-a}^{b} \sum_{q=-c}^{d} \phi_n(i + 2 \times p, h + 2 \times q) \cdot \alpha_{p,q}$$

where a,b,c,d ≥ 0, and $\alpha_{p,q}$ represents a set of normalized predetermined coefficients of said low pass filter.

21. The apparatus according to claim 20, wherein said low-pass filter is defined with a kernel

$$[\alpha_{p,q}'s]=\begin{bmatrix} 0 & 1/8 & 0 \\ 1/8 & 4/8 & 1/8 \\ 0 & 1/8 & 0 \end{bmatrix}.$$

22. An apparatus of processing interlaced video signals, which comprises:

an input for receiving a video signal with an interlaced video sequence of fields;

a spatial interpolator connected to said input and configured to spatially interpolate a value of the video signal at a given location from a video signal of at least one adjacent location in a given video field;

a temporal interpolator connected to said input in parallel with said spatial interpolator for temporally interpolating the value of the video signal at the given location from a video signal at the same location in temporally adjacent video fields; and

a computing apparatus according to claim 13 connected to said input and in parallel with said spatial interpolator and said temporal interpolator for forming a motion decision value for the same location; and

a mixer connected to receive an output signal from each of said spatial interpolator, said temporal interpolator, and said computing apparatus, said mixer being configured to mix an output signal for the video signal at the given location from the spatially interpolated signal and the temporally interpolated signal in dependence on the motion decision value output by said computing apparatus.